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Reliability of the 505 Change of Direction Test in Netball Players

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Abstract

Purpose: To determine the reliability of the 505 change of direction (COD) test performed with both a stationary and flying start. ***Methods:*** Fifty-two female netball players (age 23.9 ± 5.4 yrs, height 169.9 ± 3.3 cm, body mass 65.2 ± 4.6 kg) performed 6 trials of the 505 COD test, three with a flying start and three with a stationary start, once per week over a four week period, to determine within- and between-session reliability. ***Results:*** Testing revealed high within-session reliability for the stationary start (ICC = 0.96-0.97) and for the flying start (ICC = 0.90-0.97). Similarly, both the stationary start (ICC = 0.965) and the flying start demonstrated high reliability (ICC = 0.951) between-sessions, although repeated measures analysis of variance ($p<0.001$) revealed learning effects were found to be present between-sessions for both tests. Performances stabilized on the second day for the static start and on the third day of testing for the flying start. ***Conclusions:*** Results suggest that the 505 COD test is a reliable test in female netball players, with either a stationary or flying start. Smallest detectable differences of 3.91% and 3.97% for the stationary start and the flying start, respectively, allow practitioners to interpret whether changes in time taken to complete the 505 COD test reflect genuine improvements in performance or are measurement errors. It is suggested that one day of familiarization testing is performed for the stationary start and two days of familiarization for the flying start, to minimize learning effects.

Key Words: Agility; Learning affects; Smallest Detectable Difference; Meaningful Difference

Introduction

The importance of change of direction (COD) and agility has been highlighted in many team sports, including football, [1] rugby, [2] basketball, [3] volleyball, [4] and netball. [5-8] Emphasising high speed movements may only contribute to a low percentage of match distance covered, but they are crucial to many match winning situations, such as gaining possession and preventing or creating scoring opportunities. [1, 7, 8] During elite netball matches in particular, athletes can perform up to 81.3 ± 20.1 high-intensity sprints [6] and 63.7 ± 7.6 COD maneuvers,[5] which highlights the importance of these tasks to competitive netball performance and warrants the inclusion of agility/COD assessments within netball performance testing batteries. Agility tests are widely used within sports testing batteries to establish an athlete's ability to rapidly change direction. [3, 9] Although many tests are referred to as agility tests, they are usually methods of assessing COD performance, as agility includes a reaction to a stimulus, which is not part of the majority of these tests. [9] Many COD tests, such as the Illinois agility run, 505 COD test and T-Test, attempt to mimic common movement patterns performed within a given sport, [10] however, few studies have investigated the reliability of these tests.[2, 11, 12] Reliability of methods of assessment is highly important to ensure that sports scientists and researchers can appropriately interpret changes in performance as being meaningful or a product of the error inherent within the testing procedures adopted.

Research has reported that within-session learning effects are present during COD t-tests, but this stabilizes after only one trial.[11] The 505 COD test has also been shown to yield a reliable measure of COD amongst female softball players, with a high test-retest reliability (intra-class correlation coefficient (ICC) ≥0.93), [12] although learning effects were not reported.

Typically, the protocol for the 505 COD test allows a ten meter run up (flying start) before crossing the start line and timing commencing. Although the reliability of the 505 COD test has been investigated previously,[12] no studies have specifically assessed female netball players or compared the reliability of stationary and flying starts, or reported the potential learning affects during both tests. Identification of any systematic learning effects are essential to ensure that sports scientists and researchers apply appropriate methods when collecting baseline data, to ensure that any subsequent changes in performance are meaningful and are not due to learning effects.

The purpose of this study, therefore, was to assess the within- and between-session reliability of the 505 COD test performed with both stationary and flying (ten meter approach) starts. It was hypothesized that both tests would demonstrate a learning effect, with improved performances between the initial sessions; and that the stationary start for the 505 COD test would be the most reliable as it is easier to standardize. A further aim was to identify the smallest detectable differences in performances between-sessions to aid practitioners in determining meaningful changes in 505 COD test performances.

Methods

Experimental Design

This study assessed the within- and between-session reliability of the 505 COD test to identify the magnitude of difference which reveals a meaningful change in performance. A secondary aim was to determine if learning effects were present in trained female netball players who had no previous experience of performing the 505 COD test. Previous studies have typically assessed the between-session reliability of COD tests over two to three sessions [11, 13] and have indicated that the magnitude of observed learning effects is dependent upon both the number of trials and the task being performed. The COD tests included in the present study were, therefore, completed on the same day each week for four weeks, at the same time of day (19:00-20:00), where subjects performed six repetitions of the 505 COD test; three with a flying start and three with a stationary start. The same researcher and the coaching staff were present at all sessions to ensure that a similar level of athlete motivation was achieved between-sessions. This approach allowed within- and between-session reliability and measurement error to be calculated and learning effects to be determined. Within-session reliability was determined using the ICC, standard error of measurement (SEM), smallest detectable difference (SDD), and 95% confidence intervals. Repeated-measures analysis of variance (RMANOVA) was used to assess between-session reliability and learning effects.

Subjects

Fifty-two female players (age 23.9 ± 5.4 yrs, height 169.9 ± 3.3 cm, body mass 65.2 ± 4.6 kg, average playing experience 14.8 ± 4.9 yrs) volunteered to participate in this study. All subjects were injury free and had ≥ five years experience of playing netball for a minimum of one hour ≥ two x week. All participants provided written informed consent to participate, and the University of Salford Research and Ethics Committee approved the research and conformed to the *Code of Ethics of the World Medical Association* (Declaration of Helsinki).

Procedures

The 505 COD test requires subjects to sprint five meters, turn 180° and sprint a further five meters (Figure 1). A ‘flying start’ allowed the subject a 10 m run up before crossing the start line and timing commenced. A 'stationary start' required a static start position 0.5 m behind the start line, to prevent early triggering of the timing gates. Subjects were asked to plant their dominant foot upon executing the turn.

[***Insert Figure 1 here***]

Testing took place once a week, at the same day and time (19:00-20:00), on the same netball court, for four weeks, at the start of the competitive season. After a standardized progressive warm up, participants performed three timed attempts with both stationary and flying starts (six trials in total, per session). All times were recorded using Brower timing gates (Brower, Speed Trap 2 Wireless Timing System, UT, USA) extended to approximately hip height. The time started when a participant first passed through the timing gates and stopped when the participant passed through them again upon their return. One minute of recovery time was given between each attempt, with a three minute rest period prescribed between the flying and static starts. Participants were requested to standardize their dietary intake during each day of testing and to avoid strenuous exercise for the 48 hours prior to testing.

Statistical Analyses

Statistical analysis was performed using SPSS version 20.0 (IBM, USA). Descriptive statistics (mean, standard deviation (SD) and 95% confidence intervals) were calculated for time to complete the 505 COD test. Within-session reliability was determined using the ICC, and interpreted following the criteria of: Poor = 0.40; Fair = 0.40–0.70; Good = 0.70–0.90;

and Excellent = 0.90.[14] Between-session reliability was determined, using the best performances from each day, via ICCs and two separate (static and flying 505 COD tests) repeated measures ANOVA (RMANOVA), with Bonferroni post hoc analysis. An apriori alpha level was set at $p \leq 0.05$. Effect sizes were also measured using partial Eta squared, to determine the magnitude of difference between days, and interpreted according to the Cohen *d* method, [15] which defines 0.2, 0.5, and 0.8 as small, medium and large, respectively. The SEM was calculated from the formula ((SD(pooled) x (√1-ICC)), and the SDD was calculated using the formula (1.96 x √2) SEM). [11]

Results

Within-Session Reliability

The ICCs for both the stationary 505 (0.96-0.97) and flying 505 (0.90-0.97) showed excellent within-session reliability (Table 1).

Between-Session Reliability and Learning affects

The ICCs for both the stationary 505 (0.968) and flying 505 (0.951) also showed excellent reliability between-sessions. The RMANOVA identified significant differences between days for the stationary start [$F_{(3,153)} = 9.031$, $p<0.001$, $\eta = 0.22$, power 0.96], with Bonferroni post-hoc analysis identifying that 505 performances from a static start on days two, three and four were significantly faster (2.84 ± 0.22 s, 2.84 ± 0.23 s, 2.82 ± 0.22 s, $p \leq 0.01$, respectively) when compared to day one (2.88 ± 0.23 s). There were no significant differences ($p>0.05$) between days two, three or four (Table 1).

Similarly, there was a significant difference between days for the 505 performed with a flying start [$F_{(3,153)} = 2.319$, $p<0.01$, $\eta = 0.04$, power 0.95], with post-hoc analysis for the flying 505 identifying significantly faster performances on days three and four (2.54 ± 0.16 s, 2.52 ± 0.17 s, p≤0.01, respectively) compared to day one (2.57 ± 0.18 s). There were no additional significant differences (p>0.05) between testing days (Table 1).

[***Insert Table 1 about here***]

Discussion

The results of this study demonstrated a high within-session and between-session reliability (ICC ≥0.899) for both versions of the 505 COD test; however, both tests did demonstrate learning effects between-sessions, in line with our hypotheses. Performance in the 505 performed with a static start stabilizes after one day of familiarization, whereas the flying 505 appears to stabilize after two days of familiarization in female netball players.

The administration of COD testing, in particular the 505 COD test, is popular in team-sports [12, 16, 17]; however, it is important that the 505 COD test demonstrates high reliability so results can be interpreted appropriately. Therefore, practitioners should be are aware of the learning effects of each test. Within-session reliability of the 505 COD test demonstrated excellent reliability (ICC = 0.959-0.974), with the exception of the flying start on day one which only demonstrated a good reliability score (ICC = 0.899). A previous study also investigating female athletes reported similar reliability (ICC = 0.92), in line with our findings. [12]

There was evidence of a learning effect with significant differences (p<0.001) present between testing sessions for the stationary start and flying start. With a stationary start, days two, three and four all resulted in small but significantly (p<0.01) faster times compared to day one, although there were no differences between days two, three and four. These results demonstrate that only one day of familiarization is required for performances to stabilize during the 505 COD test performed from a stationary start. In addition, with a flying start, the only significant differences (p<0.01) were found between day one and days three and four, with no significant difference ($p>0.05$) between days three and four, highlighting that performances stabilized after two days of familiarization for the flying 505 COD test. It can be concluded, therefore, that the 505 COD test is a reliable test, when performed with either a stationary or flying start, although some familiarization is required. The difference in familiarization required between the stationary start and the flying start may be attributable to the fact that running velocity and therefore momentum is likely to be higher during the flying start. The flying start also adds the potential for additional variability in the approach velocity and therefore slightly reduces the reliability of the test. It is suggested that future research determine the variability and effect of approach speed on the reliability and performance in the flying 505 COD test.

The presence of learning effects during the administration of the 505 COD test, for both stationary and flying starts highlights the need for practice trials to be administered before testing, to ensure the most reliable outcome is achieved. We suggest two practice trials are adequate, as followed in the aforementioned protocol. The excellent to good ICC scores allow coaches to administer the 505 COD test female netball players with confidence. Munro and Herrington [11] explain that SEM values show the range in which an individual's true score is likely to lie, whereas SDD values allow practitioners to interpret whether a change in an individual's performance is significant. The SEM and SDD values gained from this research will allow coaches to evaluate true changes in performance and eliminate measurement error as a cause of change. With a base of raw data being collected, if the same protocol is followed, comparisons across netball teams and between players will be made easier.

No studies, to our knowledge, have presented the SEM and SDD values for the 505 COD test, using female participants. With no statistical evidence providing measurement error values it is difficult for coaches to identify meaningful improvements, however this study demonstrates that changes of ≥3.91% and ≥3.97% for the stationary start and the flying start, respectively, in female netball players, are meaningful. It should be acknowledged that COD was only assessed for the dominant leg in this study and therefore reliability and learning effects of the 505 COD test using the non-dominant leg may be more varied. Previous research showed that flying 505 COD times of elite female softball players decreased by 5.48% ($p=0.03$) for the non-dominant leg and by 1.09% ($p>0.05$) for dominant leg across a competitive season.[18] When applying the results of the present study to the aforementioned data, it can be reasoned that the change in flying 505 COD performance noted for the dominant leg was not meaningful which is line with the reported effect size (d = 0.43). It is suggested that future research should compare performances, reliability and learning effects of the 505 COD test variations between limbs in order to establish what a meaningful change in the performance of these tasks with the non-dominant is for future studies and to allow for a more accurate interpretation of previous findings.

Practical Applications

It is recommended that strength and conditioning coaches ensure appropriate familiarization with the 505 COD test prior to testing athletes, consisting of one familiarization session for the 505 COD performed with a stationary start and two familiarizations sessions if performed with a flying start. Additionally, differences in 505 COD times of ≥3.91% and ≥3.97% for the stationary start and the flying start, respectively, in female netball players, highlight meaningful changes. Future research should seek to determine if the level of reliability and learning effects are similar in other team sports.

Conclusion

The results of this study demonstrate a high within-session and between-session reliability for both versions of the 505 COD test. Both tests do, however, demonstrate learning effects between-sessions. Performance in the 505 performed with a static start stabilizes after one day of familiarization, whereas the flying 505 appears to stabilize after two days of familiarization, however, it should be noted that these changes between-sessions, while statistically significant, were small.

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Table and Figure Legends

Table.1. Comparison of performances (Means ± SD, 95% Confidence Intervals) and reliability statistics (ICC, SEM and SDD) across days

Trial Day	Mean ±SD (s)	95% CI	ICC	SEM	SDD (s)
Stationary 1	2.88 ± 0.23	2.80-2.93	0.959	0.05	0.130 (4.51%)
Stationary 2	2.84 ± 0.22*	2.77-2.89	0.969	0.04	0.105 (3.00%)
Stationary 3	2.84 ± 0.23*	2.77-2.90	0.971	0.04	0.105 (3.00%)
Stationary 4	2.82 ± 0.22*	2.75-2.88	0.973	0.04	0.100 (3.55%)
Mean	2.84 ± 0.22	2.78-2.90	0.968	0.04	0.111 (3.91%)
Flying 1	2.57 ± 0.18	2.51-2.61	0.899	0.06	0.16 (6.23%)
Flying 2	2.55 ± 0.17	2.50-2.59	0.974	0.03	0.08 (3.14%)
Flying 3	2.54 ± 0.18*	2.49-2.59	0.963	0.04	0.10 (3.94%)
Flying 4	2.52 ± 0.16*	2.47-2.56	0.966	0.03	0.08 (3.17%)
Mean	2.52 ± 0.17	2.48-2.56	0.951	0.04	0.10 (3.97%)

*Significantly different from Day 1 ($p \leq 0.01$)

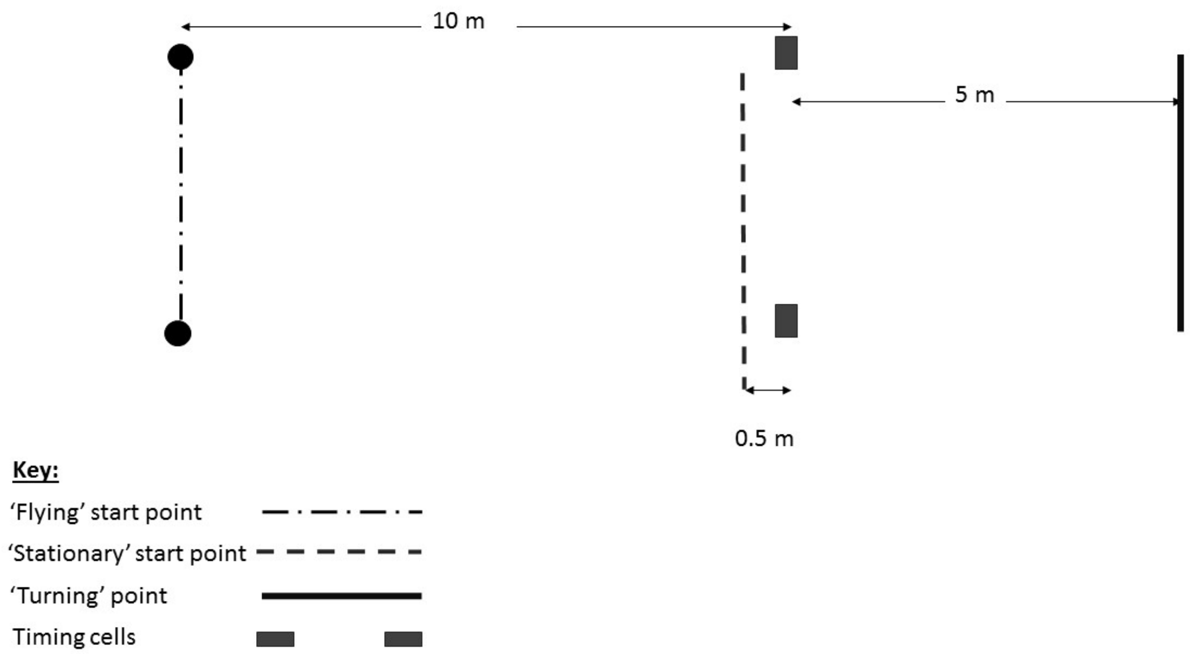

Figure 1. Example of the 505 change of direction set up.